CLAIMS

What is claimed is:

1. A laser scanning unit comprising:

a housing;

an optical system disposed in the housing and including an optical source which emits a laser beam, a mirror which scans the laser beam, and a plurality of optical elements which image the laser beam on an image surface;

a motor disposed in the housing and which rotates the mirror; and

a motor drive chip disposed outside of the housing and which uses a sensorless algorithm to control a rotation speed of the motor.

2. The laser scanning unit of claim 1, wherein the motor drive chip is mounted on a main printed circuit board of a printing machine with which the laser scanning unit is used.

3. The laser scanning unit of claim 1, wherein the motor drive chip is electrically connected to the motor by a cable.

4. The laser scanning unit of claim 3, wherein the cable is a flexible printed circuit board.

5. The laser scanning unit of claim 1, wherein the motor is a three-phase brushless DC motor.

6. The laser scanning unit of claim 1, wherein the sensorless control algorithm uses back-electromotive forces generated by the motor.

7. The laser scanning unit of claim 6, wherein the motor drive chip and the motor are connected by power supply and back-electromotive force signal lines.

8. The laser scanning unit of claim 6, wherein the motor drive chip includes:

a motor starting section which generates a motor starting signal to start the motor;

an inverter which applies current to the motor in response to the motor starting signal;

a back-electromotive force detecting section which detects back-electromotive forces generated by rotation of the motor;

a speed control section which detects a position of a rotor of the motor and a speed of the motor based on waveforms of the back-electromotive forces detected by the back-electromotive force detecting section to generate a speed control signal; and

a commutation control section which controls the inverter in response to the speed control signal.

9. The laser scanning unit of claim 8, wherein the inverter is a three-phase inverter having three terminals, three power supply lines connect the three terminals to the motor drive chip, and one electromagnetic force line connects the back-electromagnetic force detecting section to the motor.

10. The laser scanning unit of claim 8, wherein the back-electromotive force detecting section detects waveforms of back-electromotive forces and the back-electromotive forces have respective phase differences of 120°.

11. The laser scanning unit of claim 10, wherein the speed control section respectively senses zero-crossing points of the waveforms of the back-electromotive forces so as to identify the position of the rotor, and determines a rotation speed of the rotor based on amplitude and time intervals between respective phases to output the speed control signal to the commutation control section.

12. The laser scanning unit of claim 11, wherein the commutation control section controls the inverter in response to the speed control signal so as to cause the inverter to respectively supply current to the terminals of the motor in a switching order so as to rotate the rotor at a constant speed.

13. The laser scanning unit of claim 1, wherein the sensorless control algorithm uses a current supplied to the motor.

14. The laser scanning unit of claim 13, wherein the motor drive chip includes:

a motor starting section which generates a motor starting signal to start the motor;

an inverter which applies current to the motor in response to the motor starting signal;

a current detecting section which detects current supplied to the motor;

a speed control section which detects a position of a rotor of the motor and a speed of the motor based on waveforms of the current detected by the current detecting section to generate a speed control signal; and

a commutation control section which controls the inverter in response to the speed control signal.

15. The laser scanning unit of claim 14, wherein the motor drive chip and the motor are connected by power supply and current signal lines.

16. The laser scanning unit of claim 15, wherein the inverter is a three-phase inverter having three terminals, three power supply lines connect the three terminals to the motor drive chip, and two current signal lines connect the current detecting section to two of the three power supply lines.

17. The laser scanning unit of claim 16, wherein the current detecting section detects current signals of power supplied by the two of the three power supply lines.

18. The laser scanning unit of claim 17, wherein the current signals are sine wave signals.

19. The laser scanning unit of claim 18, wherein the current signals have respective phase differences of 120°.

20. The laser scanning unit of claim 19, wherein the speed control section respectively senses zero-crossing points of the current signals so as to identify the position of the rotor, and determines a rotation speed of the rotor based on amplitude and time intervals between respective phases to output the speed control signal to the commutation control section.

21. The laser scanning unit of claim 20, wherein the commutation control section controls the inverter in response to the speed control signal so as to cause the inverter to respectively supply current to the terminals of the motor in a switching order so as to rotate the rotor at a constant speed.

22. The laser scanning unit of claim 1, wherein the sensorless control algorithm uses an inductance of the motor.

23. The laser scanning unit of claim 22, wherein the motor drive chip includes:

a motor starting section which generate a motor starting signal to start the motor;

an inverter which applies current to the motor in response to the motor starting signal;

an inductance calculating section which detects current and voltage supplied to the motor to calculate the inductance of the motor;

a speed control section which detects a position of a rotor of the motor and a speed of the motor based on waveforms of the inductance calculated by the inductance calculating section to generate a speed control signal; and

a commutation control section which controls the inverter in response to the speed control signal.

24. The laser scanning unit of claim 23, wherein the motor drive circuit and the motor are connected by plural power supply lines.

25. The laser scanning unit of claim 24, wherein the inverter is a three-phase inverter having three terminals, three power supply lines connect the three terminals to the motor drive chip, and two current and voltage signal lines connect the inductance calculating section to two of the three power supply lines.

26. The laser scanning unit of claim 25, wherein the inductance calculating section detects current and voltage flowing through the three power supply lines $L_1$, $L_2$, and $L_3$ respectively.

27. The laser scanning unit of claim 26, wherein the voltage of the motor is $V=L(\theta) \times dI/dt$, wherein $L(\theta)$ is inductance.

28. The laser scanning unit of claim 27, wherein the speed control section detects the position of the rotor from waveforms of the detected inductance to output a speed control signal to the commutation control section.

29. The laser scanning unit of claim 28, wherein the commutation control section controls the inverter in response to the speed control signal so as to cause the inverter to respectively supply current to the terminals of the motor in a switching order so as to rotate the rotor at a constant speed.

30. The laser scanning unit of claim 1, wherein the sensorless control algorithm uses a third harmonic voltage of a stator of the motor.

31. The laser scanning unit of claim 30, wherein the motor drive chip includes:

a motor starting section which generates a motor starting signal to start the motor;

an inverter which applies current to the motor in response to the motor starting signal;

a third harmonic voltage detecting section which detects a third harmonic voltage of the stator of the motor;

a speed control section which detects a position of a rotor of the motor and a speed of the motor based on waveforms of the third harmonic voltage detected by the third harmonic voltage detecting section to generate a speed control signal; and

a commutation control section which controls the inverter in response to the speed control signal.

32. The laser scanning unit of claim 31, wherein the motor drive circuit and the motor are connected by plural power supply lines.

33. The laser scanning unit of claim 32, wherein the inverter is a three-phase inverter having three terminals, three power supply lines connect the three terminals to the motor drive chip, and the third harmonic voltage detecting section is respectively connected to the three power supply lines by three voltage signal lines.

34. The laser scanning unit of claim 33, wherein, when the motor rotates, a third harmonic voltage of a stator of the motor has a position component, the third harmonic voltage detecting section detects a voltage of the stator of a Y-connection and sums up all the voltages, the sum having a third harmonic voltage component.

35. The laser scanning unit of claim 34, wherein the speed control section recognizes the position of the rotor using waveforms of the third harmonic voltage with the position component, and outputs a speed control signal to the commutation control section.

36. The laser scanning unit of claim 35, wherein the commutation control section controls the inverter in response to the speed control signal so as to cause the inverter to respectively supply current to the terminals of the motor in a switching order so as to rotate the rotor at a constant speed.

37. The laser scanning unit of claim 1, wherein the sensorless control algorithm uses an electromagnetic flux generated between the stator and the rotor of the motor.

38. The laser scanning unit of claim 37, wherein the motor drive chip includes:

a motor starting section which generates a motor starting signal to start the motor;

an inverter which applies current to the motor in response to the motor starting signal;

an electromagnetic flux calculating section which detects current and voltage supplied to the motor to calculate electromagnetic flux generated between the stator and the rotor of the motor;

a speed control section which detects a position of a rotor of the motor and a speed of the motor based on waveforms of the electromagnetic flux calculated by the electromagnetic flux calculating section to generate a speed control signal; and

a commutation control section which controls the inverter in response to the speed control signal.

39. The laser scanning unit of claim 38, wherein the motor drive circuit and the motor are connected by plural power supply lines.

40. The laser scanning unit of claim 39, wherein the inverter is a three-phase inverter having three terminals, three power supply lines connect the three terminals to the motor drive chip, and the electromagnetic flux calculating section is respectively connected to two of the three power supply lines by two current and voltage signal lines.

41. The laser scanning unit of claim 40, wherein, when electric power is respectively supplied to the terminals of the motor, electromagnetic flux is generated between the stator and the rotor, the electromagnetic flux being calculable by an indirect method using the current and voltage detected by the electromagnetic flux calculating section.

42. The laser scanning unit of claim 41, wherein the stator is a coil and the rotor is a magnet.

43. The laser scanning unit of claim 41, wherein the speed control section identifies the position of the rotor using waveforms of the calculated elctromagnetic flux, and outputs a speed control signal to the commutation control section.

44. The laser scanning unit of claim 43, wherein the commutation control section controls the inverter in response to the speed control signal so as to cause the inverter to respectively supply current to the terminals of the motor in a switching order so as to rotate the rotor at a constant speed.

45. A laser scanning unit comprising:

an optical system disposed in an enclosure and including an optical source which emits a laser beam, a mirror which scans the laser beam, and a plurality of optical elements which image the laser beam onto an image surface;

a motor disposed in the enclosure and which rotates the mirror; and

a motor drive chip disposed outside of the enclosure and which uses a sensorless algorithm to control a rotation speed of the motor.

46. A laser scanning unit comprising:

an enclosure enclosing an optical source which emits a laser beam, a mirror which scans the laser beam, a plurality of optical elements which image the laser beam on an image surface, and a motor disposed in the enclosure and which rotates the polygonal mirror; and

a motor drive chip disposed outside of the enclosure and which uses a sensorless algorithm to control a rotation speed of the motor.